

## Appendix D Glossary

This glossary was developed to provide a quick reference for terms often used in the composites industry that may not be familiar to the civil engineer. It was developed primarily from "Introduction to Composites" by the Composites Institute of the Society of Plastics Industry, Inc., New York, NY.

### Additive

Any substance added to another substance, usually to improve properties, such as plasticizers, initiators, light stabilizers, and flame retardants. See also Filler.

### Aramid

A type of highly oriented organic material derived from polyamide (nylon) but incorporating aromatic ring structure. Used primarily as a high-strength high-modulus fiber. Kevlar and Nomex are examples of aramids.

### Autoclave

A closed vessel for conducting and completing a chemical reaction or other operation, under pressure and heat.

### Bulk Molding Compound (BMC)

Thermosetting resin mixed with short-strand reinforcement, fillers, and so on, into a viscous compound for compression or injection molding.

### Carbon Fiber

The element that provides the backbone for all organic polymers. Graphite is a more ordered form of carbon. Diamond is the densest crystalline form of carbon. In fiber form, carbons are used in FRP composites.

### Centrifugal Casting

A production technique for fabricating cylindrical composites, such as pipe, in which composite material is positioned inside a hollow mandrel designed to be heated and rotated as resin is cured.

### Composite Material

A combination of two or more materials (reinforcing elements, fillers, and composite matrix binder), differing in form or composition on a macroscale. The constituents retain their identities; that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another.

### Compression Molding

A process wherein a mold is open when the material is introduced and that shapes the material by the pressure of closing and by heat.

### Filament Winding

A process for fabricating a composite structure in which continuous reinforcements (filament, wire, yarn, tape, or other), either previously impregnated with a matrix material or impregnated during the winding, are placed over a rotating and removable form or mandrel in a prescribed way to meet certain stress conditions. Generally the shape is a surface of revolution and may or may not include end closures. When the required number of layers is applied, the wound form is cured and the mandrel removed.

### Filler

A relatively inert substance added to a material to alter its physical, mechanical, thermal, electrical, and other properties or to lower cost or density. Sometimes the term is used specifically to mean particulate additives.

### Glass Fiber (Fiberglass)

An individual filament made by drawing molten glass. A continuous filament is a single glass fiber of great or indefinite length. A staple fiber is a glass fiber of relatively short length, generally less than 430 mm (17 in.), the length related to the forming or spinning process used.

### Glass Transition Temperature ( $T_g$ )

The reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from, or to, a viscous or rubbery condition at hotter temperatures to, or from, a hard and relatively brittle one at colder temperatures.

### Hand Lay-up

The process of placing (and working) successive plies of reinforcing material or resin-impregnated reinforcement in position on a mold by hand.

### Injection Molding

Method of forming a plastic to the desired shape by forcing the heat-softened thermoplastic polymer into a relatively cool cavity under pressure or thermosetting polymer into a heated mold.

### Laminate

To unite layers with a bonding material, usually with pressure and heat (normally used with reference to flat

sheets, but also rods and tubes). Also a material consisting of layers bonded together.

**Lay-up**

The reinforcing material placed in position in the mold. The process of placing the reinforcing material in position in the mold.

**Plastic**

A material that contains as an essential ingredient an organic polymer of large molecular weight, hardeners, fillers, reinforcements, and so forth; is solid in its finished state; and, at some stage in its manufacture or its processing into finished articles, can be shaped by flow.

**Ply**

In general, fabrics or felts consisting of one or more layers (laminates, and so forth). The layers that make up a stack.

**Polymer**

A high molecular weight organic compound, natural, or synthetic.

**Prepreg**

Either ready-to-mold material in sheet form or ready-to-wind material, which may be cloth mat, unidirectional fiber, or paper impregnated with resin and stored for use.

**Pressure Bag Molding**

A process for molding reinforced plastics in which a tailored, flexible bag is placed over the contact lay-up on the mold, sealed, and clamped in place. Fluid pressure, usually provided by compressed air or water, is placed against the bag, and the part is cured.

**Pultrusion**

A continuous process for manufacturing composites that have a cross-sectional shape. The process consists of pulling a fiber-reinforcing material through a resin impregnation bath and through a shaping die, where the resin is subsequently cured.

**Reaction Injection Molding (RIM)**

A process for molding polyurethane, epoxy, and other liquid chemical systems. Mixing of two or more components in the proper chemical ratio is accomplished by a high-pressure impingement-type mixing head.

**Reinforced Plastics**

Molded, formed, filament-wound, tape-wrapped, or shaped plastic parts consisting of resins to which reinforcing

fibers, mats, fabrics, and so forth, have been added before the forming operation.

**Reinforced Reaction Injection Molding (RRIM)**

A reaction injection molding with a reinforcement added.

**Reinforcement**

A strong material bonded into a matrix to improve its mechanical properties.

**Resin**

A solid or pseudosolid organic material, usually of high molecular weight, that exhibits a tendency to flow when subjected to stress (e.g., polyester, vinylester).

**Resin Transfer Molding (RTM)**

A process whereby catalyzed resin is transferred or injected into a closed mold in which the fiberglass reinforcement has been placed.

**Seeman Composite Resin Infusion Molding Process (SCRIMP)**

A process which is similar in concept to RTM but requires only a single tool side and a simple vacuum bag and is capable of producing large parts.

**Sheet Molding Compound (SMC)**

A composite of fibers, a liquid thermosetting resin (usually polyester), and pigments, fillers, and other additives that have been compounded and processed into sheet form to facilitate handling in the molding operation.

**Size**

Any treatment consisting of starch, gelatin, oil, wax, or other suitable ingredient applied to yarn or fibers at the time of formation to protect the surface and aid the process of handling and fabrication or to control the fiber characteristics.

**Spray-up**

Technique in which a spray gun is used as an applicator tool. In reinforced plastics, for example, fibrous glass and resin can be simultaneously deposited in a mold.

**Thermoplastic**

Capable of being repeatedly softened by an increase of temperature and hardened by a decrease in temperature.

**Thermoset**

A plastic that, when cured by application of heat or chemical means, changes into a substantially infusible and insoluble material.

**Transfer Molding**

Method of molding thermosetting materials in which the plastic is first softened by heat and pressure in a transfer chamber and then forced by high pressure through suitable sprues, runners, and gates into the closed mold for final shaping and curing.

**Vacuum Bag Molding**

A process in which a sheet of flexible transparent material plus bleeder cloth and release film are placed over the

lay-up on the mold and sealed at the edges. A vacuum is applied between the sheet and the lay-up.

**Wet Lay-up**

A method of making a reinforced product by applying the resin system as a liquid when the reinforcement is put in place.